NASA Procedural Requirements

COMPLIANCE IS MANDATORY

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Subject: Systems Engineering Procedural Requirements

Responsible Office: Office of the Chief Engineer

Chapter 1. álntroduction

1.1 Background

1.1.1 Systems engineering at NASA requires the application of a systematic, disciplined engineering approach that is quantifiable, recursive, iterative, and repeatable for the development, operation, maintenance, and disposal of systemsáintegrated into a whole throughout the life cycle of a project or program. The emphasis of systems engineering is on safely achieving stakeholderáfunctional, physical, and operational performance requirements in the intended use environmentsáover the system's planned life within cost and scheduleáconstraints.

1.1.2 This NPRáestablishes a core set of common Agency-level technical processesáand requirements needed to define, develop, realize, and integrate the quality of the systemáproducts created and acquired by or for NASA. The processesádescribed in this documentábuild upon and apply best practices and lessons learned from NASA, other governmental agencies, and industry to clearly delineate a successful model to complete comprehensive technical work, reduce program and technical risk, and improve missionásuccess. The set of common processes in this NPR may be supplemented and tailored to achieve specific project requirements. (See Appendix F. Tailoring.)

1.1.3 Under the lean governance of the updated NPD 1000.0, the relationship of the program/project management and the technical team was clarified to reflect new technical authority. The program/project manager (PM) has overall responsibility for their program/project. The technical team works with and for the PM to accomplish the goals of the project. Due to this updated governance, there is a need to clearly define the role of the systems engineering management plan (SEMP) and how it will be developed. The technical team, working under the overall program management plan (PMP), develops and updates the SEMP as necessary. The technical team works with the PM to review the content and obtain concurrence. This allows for thorough discussion and coordination of how the proposed technical activities would impact the programmatic, cost, and schedule aspects of the project. However, in cases of pure technical issues and for approval of requested waivers to technical requirements, the technical team also has an independent route through the technical designated governing authority (DGA) (as described in Section 2.3) to resolve issues with program/project management. Once all issues are resolved, the PM signs the SEMP. It then goes to the DGA for final signature. The DGA signature assures that an independent review has evaluated the technical aspects of the technical plans and allows for approval of technical waivers or tailoring of the requirements of this NPR and other relevant technical standards that pertain to this NPR.

1.1.4 Precedence

The order of precedence in case of conflict between requirements is 42 U.S.C. 2473(c)(1), Section 203(c)(1), National Aeronautics and Space Act of 1958, as amended; NPD 1000.0, Strategic Management & Governance Handbook; NPD 1000.3, The NASA Organization; NPD 7120.4, Program/Project Management; and NPR 7123.1, NASA Systems Engineering Processes and Requirements.

1.1.5 Requirement Verbs

In this NPR, a requirement is identified by "shall," a good practice by "should," permission by "may," or "can," expected outcome or action by "will," and descriptive material by "is" or "are" (or another verb form of "to be").

1.1.6 Figures

Figures within this NPR are not intended to be prescriptive but notional.

1.2

Framework for Systems Engineering Procedural Requirements

There are three major groupings of requirements within the Office of the Chief Engineer (OCE), i.e., program management requirements, systems engineeringárequirements, and independent review. This NPR focuses on the systems engineering requirements. (See Appendix E for the hierarchy of related documents.)

1.2.1 SystemsáEngineering Framework

1.2.1.1 The common systemsáengineering framework consists of three elements that make up NASA systems engineeringácapability. The relationship of the three elements is illustrated in Figure 1-1. The integrated implementation of the three elements of the SEáFramework is intended to improve the overall capability required for the efficient and effective engineering of NASA systems. The SEáprocessesáare one element of the larger context to produce quality products and achieve missionásuccess. This NPRáaddresses the SE processes. The larger SE framework also includes the workforce and tools and methods. OCEáinitiatives to address these other elements include revision of the NASA handbook on systemsáengineering and development of tools and an assessmentámodel. Together, these elements comprise the capability of an organizationáto perform successful SE. Each element is described below.

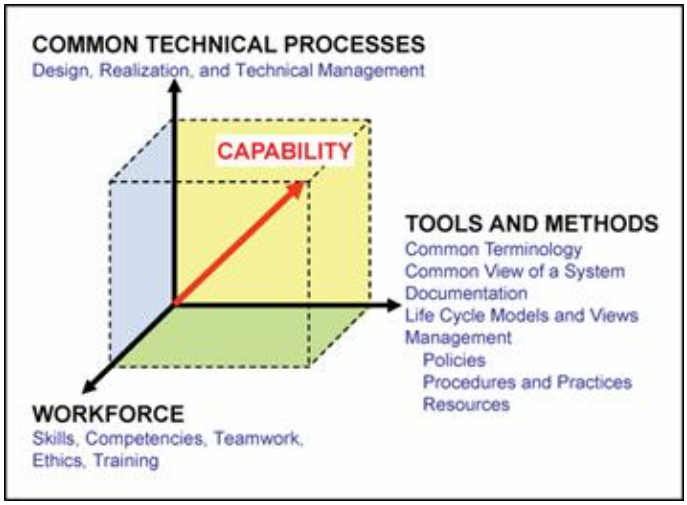

Figure 1-1 - SEáFramework

1.2.1.2 Element 1: Common Technical Processes. The common technical processes of this NPR provide what has to be done to engineer system products within a project and why. These processes are applied to the hardware, software, and human parts of a system as one integrated whole. Within this NPR, the contribution of this element to improvement of SE capability is made not only by the common set of technical processes but also by inclusion of:

a. Concepts and terminology that are basic to consistent application and communication of the common technical processes Agency-wide.

b. A structure for when the common technical processes are applied.

1.2.1.3 Element 2: Tools and Methods. Tools and methods enable the efficient and effective completion of theáactivitiesáand tasks of the common technical processes. An essential contribution of this element to SE capability is the improvement of the engineering infrastructure through the three Agency-wide initiatives listed below.

a. Infusion of advanced methods and tools in the SEáprocessesáto achieve greater efficiency, collaboration, and communication among distributed teams.

b. Preparation of a NASA handbook on SEámethodologies intended to provide a source for various methods and procedures that Centers can draw upon to plan implementation of the required processesáin their projects. This will be an update of the current NASA Systems Engineering Handbook (SP-6105) that will be aligned with NPRá7120.5

and the SE NPR.

c. Creation or adoption of an assessmentámodel to measure the SEácapability of projects within NASA and to assess the improvements of capability resulting from implementation of the SE NPR, use of adopted methods and tools, and workforce engineeringátraining.

1.2.1.4 Element 3: Workforce. A well-trained, knowledgeable, and experienced technical workforce is essential for improving SE capability. The workforce must be able to apply NASA and Center standardized methods and tools for the completion of the required SEáprocessesáwithin the context of the program or project to which they are assigned. In addition, they must be able to effectively communicate requirements and solutions to customers, other engineers, and management to work efficiently and effectively on a team. Issues of recruitment, retention, and trainingáare aspects included in this element. The OCE will facilitate the training of the NASA workforce on the application of this and associated NPRs.

1.2.1.5 SE Capability Together, the three elements of Figure 1-1 comprise an Agency-wide capability to perform successful SE in the engineering of NASA system products.

1.3 SystemsáEngineeringáManagementáPlan

A SystemsáEngineeringáManagementáPlaná(SEMP) is used to establish the technical content of the engineeringáwork early in the FormulationáPhase for each project and updated throughout the project life cycle. The SEMP provides the specifics of the technical effort and describes what technical processesáwill be used, how the processes will be applied using appropriate activities, how the project will be organized to accomplish the activities, and the cost and scheduleáassociated with accomplishing the activities. The process activities are driven by the critical or key events during any phase of a life cycle (including operations) that set the objectives and work product outputs of the processesáand how the processes are integrated.á(See Chapter 6 for a description of the SEMP and Appendix D for an annotated outline for the SEMP.) The SEMP provides the communication bridge between the project managementáteam and the technical implementation teams and within technical teams. The SEMP provides the framework to realize the appropriate work products that meet the entry and exit criteriaáof the applicable project life-cycle phases and provides management with necessary information for making decisions.á

1.4 Document Organization

This document is organized into the following chapters.

a. The Preface describes items such as the applicability, scope, authority, and references ofthis SE NPR.

b. The Prologue describes the purpose and vision for this SE NPR.

c. Chapter 1 describes the SEáframework and introduces the SEMP.

d. Chapter 2 describes the institutional and programmatic requirements, including roles and responsibilities.

e. Chapter 3 describes the core set of common Agency-level technical processesáand requirements for engineeringáNASA systemáproducts throughout the product life cycle. Appendix C contains supplemental amplifying material.

f. Chapter 4 describes the activitiesáand requirements to be accomplished by assigned NASA technical teamsáor individuals (NASA employees and their service support contractors)áwhen performing technical oversight of a prime or external contractor.

g. Chapter 5 describes the technical reviews throughout the SEálife cycles with clear differentiation between management reviewsáand engineeringáreviews.

h. Chapter 6 describes the SEMPáin general detail, including the SEMP role, functions, and content. Appendix D provides details of a generic SEMP annotated outline.

| TOC | Change History | Preface | Prologue | Chapter1 | Chapter2 | Chapter3 | Chapter4 | Chapter5 | Chapter6 | AppendixA | AppendixB | AppendixC | AppendixD | AppendixE | AppendixF | AppendixG | AppendixH | AppendixI | AppendixJ | ALL |

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